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4 March 1964

MEMORANDUM FOR THE RECORD

SUBJECT: Trip Report [REDACTED] PERCEPTRON Applicability 25X1  
to PI.

1. Agenda.

- a. Introduction [REDACTED]
- b. PERCEPTRON Research Results [REDACTED] 25X1
- c. Culture Pattern Recognizer [REDACTED] 25X1
- d. Demonstration of Breadboard Spatial Frequency Analyzer.
- e. [REDACTED] was present at entire conference.

2. Introduction. [REDACTED]

- a. Pattern Recognition Process.
  - (1) Measurements.
  - (2) Computation - weight - integrate
  - (3) Properties.
  - (4) Classification Function.

Declass Review by NGA.

- b. PERCEPTRON.
  - (1) Picture element, dark-light.
  - (2) A units.
  - (3) A unit output.
  - (4) Linear weighting.
- c. Property Space.
  - (1) Linear separation.
  - (2) Non-linear.
  - (3) Multi-dimensional space.

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d. Weight Space.

- (1)  $w_1x_1 + w_2x_2 + w_3x_3 + \theta \leq 0$  Set of simultaneous linear inequalities.
- (2) When  $w_1x_1 + w_2x_2 + w_3x_3 + \theta = 0$ , then solution in w space is linear, straight line, hyperplane.
- (3) When  $\sum w_i x_i \leq 0$  then the solution area is bounded convexly.

3. PERCEPTRON Research Results.

a. Limitation of significance by small sample sizes.

b. Test set must be different than the training.

(1) Prototype,  $P_1$

add noise

(2) Prototype,  $P_2$

$P_{11}, P_{12}$	—	—
$P_{21}, P_{22}$	—	—
train		test

c. Examine effects of changes in the prototype on the PRS (pattern recognition system).

(1) Pattern noise.

(a) Placement - translation and rotation.

(b) Size variations.

(c) Density distortion.

1. Grey.

2. Silhouettes.

a. Random noise.

b. Connected noise.

c. Reversal.

d. Further testing of the PERCEPTRON.

(1) Number of S-A unit connections.

(2) Number of A units.

(3) Take determination properties also.

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- e. Error rate significantly affected by number of "A" units (inflection at 100).
- f. Error rate significantly insensitive to variation in number S-A connections.
- g. Generalization technique.

NOTE: Company sponsored construction of an independent PERCEPTRON research tool with 200X capacity and 10X speed of existing systems.

4. Two-dimensional Spatial Filtering,  25X1

- a. One photo area used to generate many properties.
- b. Choose a property (filter), then scan each area of the photo. This approach required great storage capacity.

5. Demonstration of Breadboard Spatial Frequency Analyzer.

6. Final Report will use about  25X1

- a. Substantiate work with graphs and photographs.
- b. Implications for the future.
- c. Analysis of year's work.

7. Question the extensive learning process required for the PERCEPTRON. Asked why one presentation of the prototype could not provide recognition of 50% correlation thereafter.

8. Advised that if they wish to propose:

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- a. Keep below  25X1
- b. Only unique approach.
- c. Only demonstrated feasibility.

Development Branch, P&DS

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WOW  
6 May 63

TRIP REPORT

24 April 1963

DATE: 23 April 1963, 1100 - 1600

PLACE: Rome Air Development Center  
Griffiss Air Force Base  
Rome, New York

ATTENDEES:

[Redacted box]

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PURPOSE: To ascertain the scope of investigation of automatic image recognition techniques being supported by RADC and to obtain an educated opinion regarding the advisability of NPIC supporting the [Redacted box] (PERCEPTRON) effort in this realm.

DISCUSSION:

1. [Redacted box] is the individual at RADC who is most cognizant of developments in the realm of automatic image recognition. It was explained that most of the effort in this direction which has been supported by RADC was initiated by him, but that such effort has been considerably hampered by the following factors:

- a. lack of direct contact with operational P.I. circumstances.
- b. limited opportunities for testing systems with operational P.I.'s.
- c. pertinent information restraints caused by security classification.
- d. reluctance caused by the lack of information throughout the intelligence community regarding the potential magnitude of the collection effort and the consequent workload in the exploitation phase.

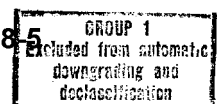
2. In spite of these limitations, RADC has given considerable support to developments related to automatic image recognition. The following paragraphs briefly describe the nature and status of the current investigations in this realm which are under the cognizance [Redacted box]

- a. Fully Automated Target Recognition System. According to [Redacted box] the current levels of achievement do not indicate feasibility for development of such a comprehensive system before 5-6 years. One internally-postulated system under consideration at RADC would assist the PI by a machine prepared report identifying approximately 65% of the intelligence on the photography. Such a system would require extensive testing under operational P.I. circumstances to determine the significance of its contribution. No satisfactory testing facilities are available to RADC at this time.

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b. Photographic Quality Parameters of Most Significance to Photointerpretation.

[redacted] has recently completed a study in this regard. [redacted] explained that the significance of this study was limited by the lack of trained P.I.'s for testing. The study verified the fact that ground resolution is by far the most important single criterion. A means of determining resolution from various continuous-tone images was a by-product of the study. [redacted] is now under contract to determine quantitative relationships between resolution, acutance, contrast and granularity as each contributes to the interpretability of a photo image.

c. Psychological Studies of the P.I. Process. Applied Psychology Lab is performing studies to determine means of speeding up the visual recognition process. [redacted] is performing Taschistoscopic Training Studies (improving visual recognition speed by successively decreasing the time of presentation, as in WWII Aircraft Recognition Training). The purpose is to determine whether or not incorporation of this technique would improve P.I. training.

d. Change Detection. [redacted] is engaged in development of a change detection system which is required to overcome previous difficulties caused by changes in sun angle, camera orientation and relief distortion. [redacted] is developing digital computer logic and programs for the purpose of reconciliation of images which do not exhibit a significant change; accentuating significant changes. An extensive study in this regard has been accomplished. The title of the resultant report is, Electronic Correlation Techniques for Change Detection.

e. Spatial Filtering by Optical Diffraction. [redacted] has completed a thorough study of this phenomenon as it is related to pattern recognition. Much of this study is similar to the NPIC-sponsored study at Itek.

f. Image Motion Deblurring. [redacted] has submitted an unsolicited proposal dated February 1963, which describes a means for reducing the blur of photo images caused by uncompensated motion during exposure.

g. Automatic Target Recognition Systems. In addition to the indirectly related developments described above RADC has investigated or supported developments which are directly related to the problem of automatic target recognition by the following facilities:



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All of these endeavors with the exception of that being performed [ ] are derived from the PERCEPTRON concept, which originated [ ] The work at [ ] is a comprehensive investigation of many different video-optical techniques. Many different types of scanning techniques and optical and electronic filtering have been evaluated. An experimental prototype Semi-Automatic Target Recognition Device employing the most promising of these techniques has been assembled. The device is now being used to perform statistical analyses of the identification and discrimination potential of these systems.

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3. In light of all these factors it was determined that [ ] concurred with the tentative decision to support the [ ] for at least another year. It was agreed that [ ] possessed the broadest base of experience in the development of cognitive systems and that there was no indication at the present time of any other system with enough promise to exclude the continued support of the [ ] investigations.

#### CONCLUSIONS:

1. The field of Automatic Image Recognition is so broad that extensive liaison will be required to maintain a well-balanced development program. Contact with agencies such as RADC must be established and maintained on a systematic basis. Similar contact must be arranged with commercial facilities involved in related developments. Technical competence to assimilate and evaluate these developments must be achieved and maintained. All this will require considerable manpower, at least the equivalent of one man-year per year.

2. Support of development in this field is definitely indicated by the predicted increases in quantity and quality of source materials.

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3. The opportunity to support the work of the [ ] in this field provides an excellent entree for the Center. The stature and comprehension of the [ ] effort are appropriate to the Center's position of leadership. The knowledge available there will provide an excellent reference for technical staff members to become familiar with this field of endeavor.

4. The general nature and broad scope of this development demands reasonable free exchange within the scientific community. RADC has realized significant inhibitions arising from so-called "proprietary" developments and security classification.

#### RECOMMENDATIONS:

1. That NPIC organize and implement a program for development of automatic image recognition systems.

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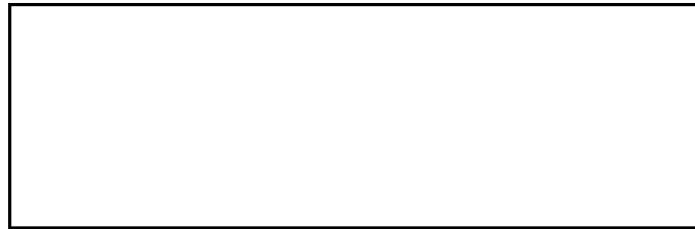
2. That immediate support of the  be the means of initiating this program.

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3. That every practicable effort be made to accomplish this task under such cover that government agencies and appropriate private industries may have reasonable access to the research project and the resultant data.

4. That NPIC consider means whereby members of the operational PI staff may be made available for testing and evaluating developments in this field.

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